without any mathematics. The surface of the ocean, apart from waves and tides, is at any time a figure of equilibrium answering to the speed of rotation at the time, more oblate when the speed is greater, less oblate when it is slower. Let us imagine that the lithosphere also is at some time a figure of equilibrium answering to the speed of rotation at that time. If the speed remained constant, the lithosphere would retain this figure, and the matter within it would remain always in the same configuration without having to support any internal tangential stress. Now suppose that the speed of rotation gradually diminishes. The surface of the ocean will gradually become less and less oblate. The lithosphere also will gradually become less oblate, but not to such an extent as to make it a figure of equilibrium answering to the diminished speed of rotation, while the matter within it will get into a state of gradually increasing internal tangential stress. The effect on the distribution of land and water will be that the depth of the ocean will gradually diminish in lower latitudes and increase in higher latitudes, the latitudes of no change being 35° 16′ N. and S.

The internal tangential stress in the matter within the lithosphere may increase so much that it can no longer be supported. If this happens a series of local fractures will take place, continuing until the lithosphere is again adjusted much more nearly to a figure of equilibrium, which will be less oblate than the original figure. The effect on the distribution of land and water will be that the depth of the ocean will increase rather rapidly and spasmodically in lower latitudes and diminish in higher latitudes.

Accordingly the kind of geological change which the theory of tidal friction would lead us to expect is a sort of rhythmic sequence, involving long periods of comparative quiescence, marked by what Suess calls "positive movements of the strand," in the higher latitudes, and "negative movements" in the lower, alternating witih comparatively short periods of greater activity, marked by rise of the land around the poles and subsidences in the equatorial regions. It is for geologists to say whether the facts known to them are consistent with this description or not.

A. E. H. LOVE.

The Age of a Herring.

IN the issue of NATURE for September 17 Prof. D'Arcy Thompson states that he is unable to persuade himself of the validity of Dr. Hjort's conclusions based upon the methods of determining the age of herrings by a study of their scale-rings.

It is, of course, impossible to attempt to deal in a few words with all the evidence brought forward in favour of these methods in recent years by different biologists, and we must, with regard to the herring, refer to our published papers,[1] where arguments are given in favour of the primary assumption that the age of a herring may be determined by counting the rings seen on its scales. The facts supporting this assumption are briefly:—

(1) For young individuals (up to age of three years) the results of age determinations by means of the scale-rings correspond with the results obtained by plotting frequency curves for the length measurements of the individuals.

(2) Scale examination of small herrings continued with short intervals during all seasons showed that the formation of the so-called winter rings took place during the winter, while the formation of the so-called summer belts commenced in the spring and continued during the summer months. That the summer belt is small at the commencement of the formation in May, while it is large on the completion of the formation in the beginning of autumn, has been proved by observations carried on during four years. Regarding the older fish, it has been difficult to proceed in the same manner as for younger fish, as the frequency curves fail to give any hints as to the age groups represented in a sample, while, on the other hand, the fishing season for the old herrings does not extend over all seasons of the year. The following facts point to the correctness of the assumption that the conditions here are strictly homologous to the conditions as regards the younger fish.

(3) Among the Norwegian herrings a great many individuals had an abnormally small third summer belt on their scales. Herrings showing this abnormality have been very frequently observed during all the years from 1907 to 1914, but while the scales of these herrings in the year 1907 had only one summer belt outside the abnormal one in 1908, they showed two summer belts, and so on until the winter 1913–14, when they had seven summer belts outside. Thus these herrings, so easily distinguishable by their abnormality, have during the seven years of observation annually formed one summer belt on their scales, each belt being separated by a winter ring from the preceding and succeeding belts.

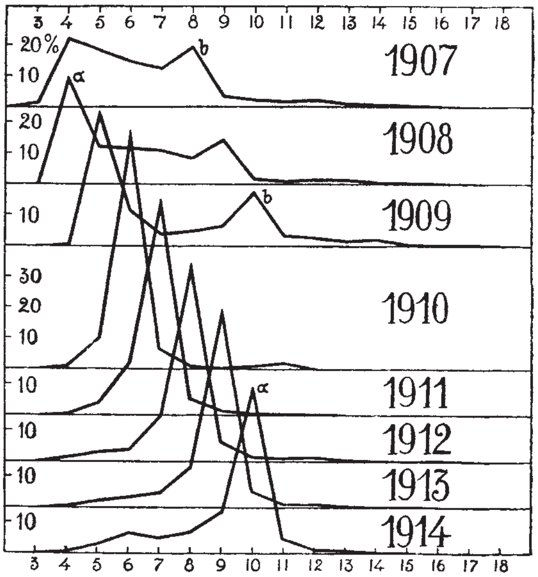

FIG 1.—Showing the captures of Norwegian mature herrings for eight successive years, arranged in percentage frequency curves according to the number of rings on the scales (the numbers along the abscissa denoting the ring groups).

(4) By scale investigations on the Norwegian spring herrings (spawning herrings), carried out during the years from 1907 to 1914, results are obtained the main points of which are given in Fig. 1. This diagram is based upon all the material from 1907–13, while for 1914 part of the material was not worked up when the diagram was constructed (still the curve for this year is based upon more than 2000 individuals).

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[1] Hjort, "Report on Herring Investigations until January, 1910," *Publ. de Circonst.*, No. 53. Copenhagen, 1910.
Hjort and Lea, "Some Results of the Internat. Herring Inv., 1907–11. *Publ. de Circonst.*, No. 61. Copenhagen, 1911.
Hjort, "Fluctuations in the Great Fisheries of Northern Europe," *Rapports et Procès-Verbaux*, vol. xx. Copenhagen, 1914.
Lea, "On the Methods used in the Herring Investigations," *Publ. de Circonst.*, No. 53. Copenhagen, 1910.
Lea, "A Study on the Growth of Herrings." *Publ. de Circonst.*, No. 61. Copenhagen, 1911.
Lea, "Further Studies concerning the Methods of calculating the Growth of Herrings," *Publ. de Circonst.*, No. 66. Copenhagen, 1913.

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The diagram shows, for each year of observation, the percentage frequency of the individuals according to the number of rings on their scales, the figures along the abscissæ denoting the number of rings, while the corresponding ordinates denote the percentages of all the individuals falling in each ring group.

The most prominent feature of this diagram is the regular movement of the primary mode (*a*) from 1908–14, as well as of the secondary mode (*b*) from 1907–09.

While in 1908 the individuals having 4 rings were the most numerous, in 1909 those having 5 rings, in 1910 those having 6 rings, in 1911 those having 7 rings, in 1912 those having 8 rings, in 1913 those having 9 rings, and in 1914 those having 10 rings predominate.

In the same manner the secondary mode (*b*), appearing in 1907 by the relative numerical strength of group 8, moves one class to the right for each of the years 1908 and 1909.

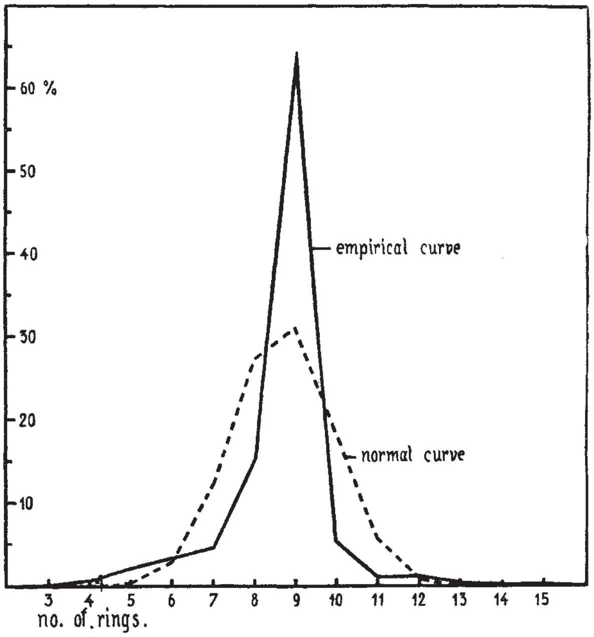

FIG. 2.—Comparison between the empirical ring curve for 1913 (in Fig. 1) and its corresponding normal variation curve.

It seems difficult to explain this regular movement of the modes, unless we assume that the two prominent modes represent two relatively abundant year-classes of herrings.

If this be true, then the material investigated leads to the conclusion that great fluctuations occur in the stock of Norwegian herrings with regard to the relative abundance of the different year-classes. That the magnitude of these fluctuations is astonishing and "very hard to imagine," is by no means an argument against the observed facts.

Prof. D'Arcy Thompson emphasises the regularity with which the so-called year-groups arrange themselves in a unimodal skew-curve, "just as the same fish group themselves also, according to size, in a unimodal but more normal curve." It seems to him "statistically improbable that a dozen separate generations of herrings, spawned in as many years, should have entered into the formation of the composite shoal in these curiously and regularly graded proportions." He finds it much easier to explain this fact by assuming that all the herrings (in a sample) were *of the same age and origin,* and that consequently the individual herrings vary about a certain modal number of rings, just as they also vary in a normal fashion about a certain modal size. He also emphasises the probability of an irregular age-curve for a population where large and irregular fluctuations occur in the annual birth-rate.

It might have been expected, then, that Prof. D'Arcy Thompson would have subjected the material published to a statistical analysis in order to convince himself of the correctness of his opinion regarding the similarity between the age-curves and the normal curves so usual in biology. He would then have found that no age-curve in the whole material of Norwegian herrings follows the usual law for biological variation. In some cases the age-curves present themselves by mere inspection as irregular (see Fig. 1, 1907, 1908, and 1909), while in other cases (when the curve is unimodal, as in Fig. 1, 1910–14) they are so entirely different from the normal frequency curve that it is totally impossible to replace the empirical curve by the corresponding theoretical one. This will be apparent from Fig. 2, giving the empirical age-curve for Norwegian herrings in 1913 (see Fig. 1) together with the normal curve for the same number of individuals, the same average and standard deviation, and the same arrangement of classes. In the following table the same data are given numerically:

Number of scale rings	Empirical frequencies in percentages	Theoretical frequencies in percentages	Difference empirical—theoretical values
3	0·1	0·0	0·1
4	0·7	0·0	0·7
5	2·2	0·4	1·8
6	3·4	3·0	0·4
7	4·8	12·5	− 7·7
8	15·4	27·4	−12·0
9	64·7	31·2	33·5
10	5·2	18·5	−13·3
11	1·2	5·8	− 4·6
12	1·3	0·9	0·4
13	0·5	0·1	0·4
14	0·2	0·0	0·2
15	0·2	0·0	0·2

The dissimilarity of the two curves is, in fact, so great as to exclude any idea of the age-curve following the usual law for biological variation. The feature that the curve is apparently unimodal, is due to the fact that one single group is so overwhelmingly abundant as to depress to a certain degree the irregularities actually existing in the frequencies of the other groups. By inspection of the age-curve for 1914 (see Fig. 1) it will be observed that the frequency of group 11, lying close to the modal group, is less than for the more extreme groups 6, 7, and 8.

For these reasons, as well as because of the regular movement of the modes, it seems to us impossible to explain the observed facts as a result of common variation, even if the help of a mathematical statistician were enlisted.

JOHAN HJORT.
EINAR LEA.

Scientific Work and the War.

DR. CALMAN's plea (NATURE, October 22, p. 198) for the continuance as usual of the work of our learned societies, or even a wider plea for the calm prosecution of all our scientific studies, may be supported on many grounds, but the only one that I wish to emphasise is the moral effect thus produced upon those neutral nations whom our opponents seek to delude into the belief that we are panic-stricken. To the

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